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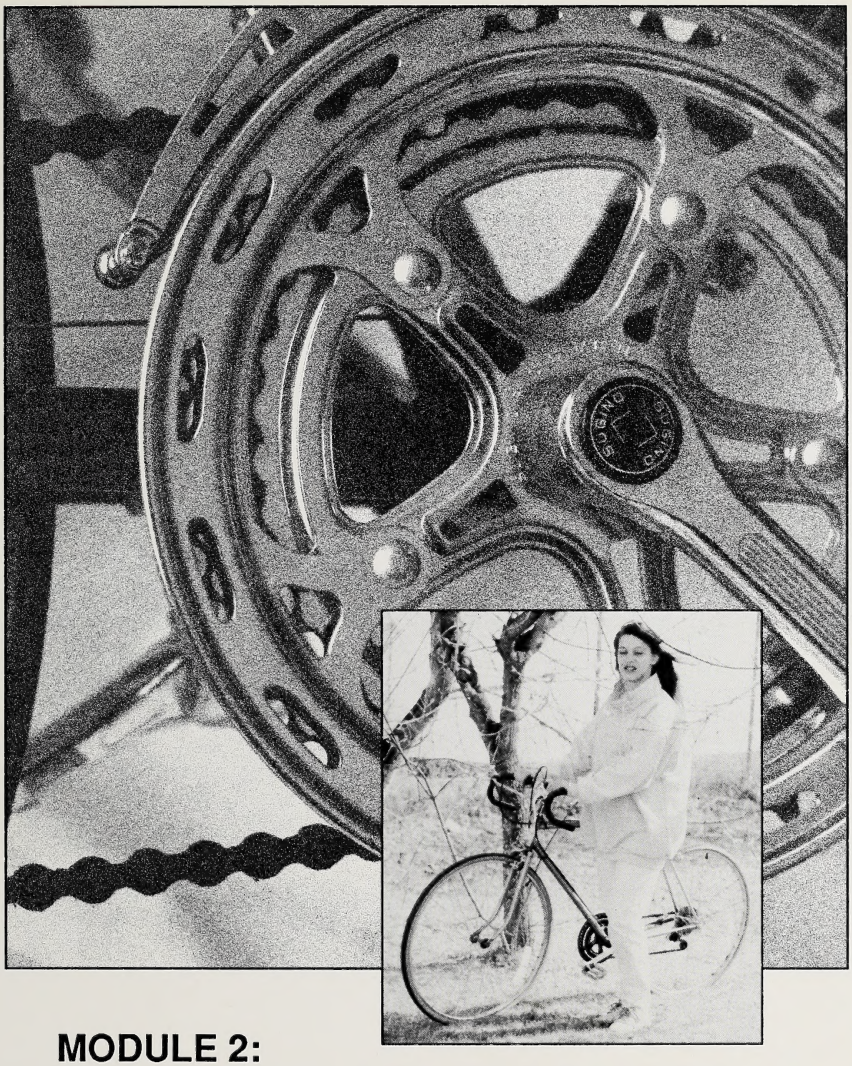

MODULE 2:
Energy and Machines

STUDENT SUPPORT GUIDE

Distance Learning

Alberta EDUCATION

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Science 8

Module 2

STUDENT SUPPORT GUIDE

Distance Learning

Alberta EDUCATION

Note to the Parent or Guardian

This Science Student Support Guide contains answers to activities in the accompanying Module Booklet. It should be kept secure by the parent or guardian if the student is under 16 years of age. Younger students should not have access to this Guide except under supervision.

This Student Support Guide does not contain the answers to the accompanying Assignment Booklet. The Assignment Booklet will be graded by the student's distance education teacher.

Science 8
Student Support Guide
Module 2
Energy and Machines
Alberta Distance Learning Centre
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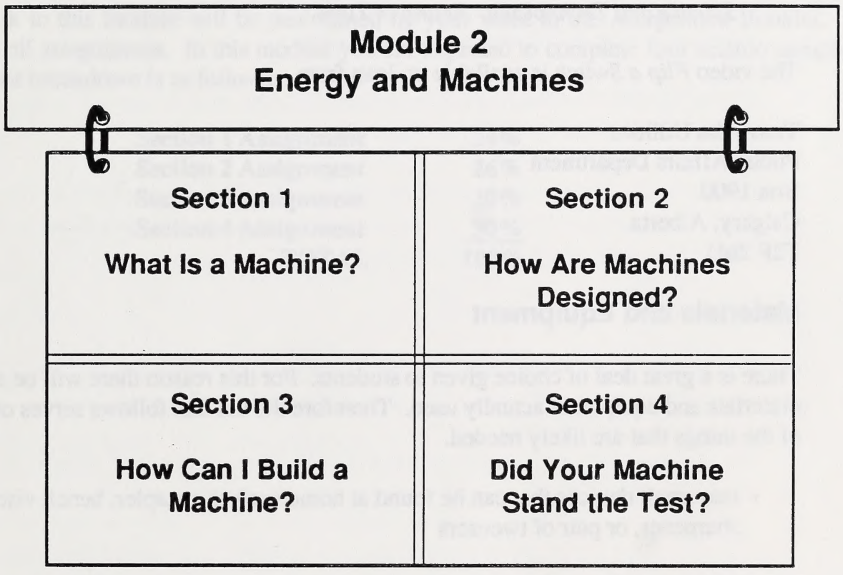
Module 2 – Energy and Machines: Overview

The major emphasis of this module is science and technology.

This module is a study of mechanical systems. Mechanical devices are analysed in terms of systems and subsystems and their functions. In constructing devices and making improvements to devices, students learn to appreciate energy conservation and efficiency in design. Students also consider various forms of energy and energy conversions.



Classroom Opener

Ask students what machines they used yesterday. Besides the more complex machines such as the bicycle and automobile, attention should be drawn to uncomplicated machines such as a pair of scissors and a can opener. It should become clear that machines are almost everywhere around us at home and at school. All machines are designed to serve a purpose and to make life easier. Tell students that in this module students will have the opportunity to practise designing and building their own machines.

Media

Videocassettes may be available from the Alberta Distance Learning Centre – Junior High Department or your local school jurisdiction.

The following video has been included in a pathway in this module:

Simple Machines

The following videos are not included in the pathways but may be found useful:

- *Flip a Switch*
- *National Geographic Specials: Man – The Incredibe Machine*
- *Science and Technology: Acting in Turn*

The video *Flip a Switch* is available on loan from

TransAlta Utilities
Public Affairs Department
Box 1900
Calgary, Alberta
T2P 2M1

Materials and Equipment

There is a great deal of choice given to students. For this reason there will be a wide variety in the materials and equipment actually used. Therefore the list that follows serves only as a guide to some of the things that are likely needed.

- two small devices that can be found at home such as a stapler, bench vise, can opener, pencil sharpener, or pair of tweezers
- a larger device such as a model toy, lawn mower, or appliance
- a bicycle is recommended but not required
- a spring scale is suggested but not required
- a construction set is recommended but not required
- a device with gears such as a toy, can openers, old watch, or ornamental clock
- a string or thread
- a smooth board
- a pulley, old spool, or curtain drape part

- a hook or clamp
- a weight to serve as a load, e.g., block of wood
- additional materials for construction of a machine: tape, paper, cardboard, paper clips, screws, glue, straws, tongue depressors, wooden dowels, wheels (margarine dish lids), pins, balls, spools, springs, toothpicks, bolts and nuts, elastic bands, propellers, battery-powered motors

Evaluation

Your mark in this module will be determined by your work in the Assignment Booklet. You must complete all assignments. In this module you are expected to complete four section assignments. The assignment breakdown is as follows:

Section 1 Assignment	**24%**
Section 2 Assignment	**26%**
Section 3 Assignment	**20%**
Section 4 Assignment	**30%**
TOTAL	**100%**

Section 1: What Is a Machine?

Section 1: Activity 1

1. Write your story on the lines that follow.

Student answers will vary but should contain the four basic steps of problem solving.

Understanding the Problem: *The student should state the problem clearly. Variables such as the ability to move the object from point A to point B safely and without damage should be explained.*

Developing a Plan: *Some students may jump into trying something immediately without taking time to think of a plan. Try to encourage students to think out a solution even if it is only a brief sentence or two indicating a plan is in place.*

Carrying Out the Plan: *Students should describe what happened as they carried or lifted the object. Did their plan work? What did they observe?*

Evaluating: *In their story, students should indicate the degree of success they had with the plan. Was the object lifted or carried safely without damage. Did they have to change their plan? Could they have done it a different way?*

A sample answer follows:

Understanding the Problem: *Another person and I had to move a desk through a doorway in the house. The problem seemed to be that the desk would not fit through the door.*

Developing a Plan: *Initially we tried to get it through the door by turning it, then by standing it on end but it still would not go through. We did not have a plan.*

Carrying Out the Plan: *We found that we could not carry it through sideways or vertically so we paused and thought about it. The desk was carried downstairs through the door so it must fit going up the stairs. We decided to measure the dimensions of the desk then the dimensons of the door. We found it would fit but very tightly. It was then we got the ideas to take the door off the hinges. That was all we needed; the desk was then carried through the door.*

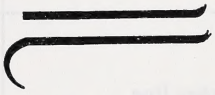
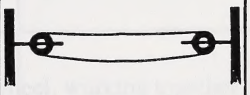
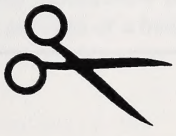
Evaluating: *We were pretty happy that we finally got the desk through the door however not so happy that it took so long. We realized that we should have measured the desk first; we needed a plan. Next time I would think it through first. We did mark the wall a bit before we took the hinges off because we tried to force the desk through the door.*

Section 1: Activity 2

The video *Simple Machines* is incorporated in a pathway of this activity.

1. Using either the video or the reading, fill in the chart. For each simple machine give an example of a device that uses it. Sketch your example.

   Examples of simple machines may vary. A sample answer follows.

Type of Simple Machine	Example of a Device Using this Simple Machine	Sketch of Device
Lever	*Crowbar*	
Pulley	*Clothes line*	
Wheel and Axle	*Wheelbarrow*	
Inclined Plane or Ramp	*Car ramps*	
Screw	*Wood screw*	
Wedge	*Scissors*	

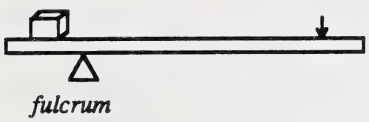
2. For each device placed in the chart for question 1, describe its main use or function. For example, if there were a baseball bat in the previous chart, you would give its function as allowing the batter to hit a baseball into the field or over the fence.

Answers will vary; however, students should be able to state the purpose of the device:

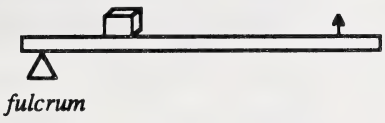
Example of a Device Using a Simple Machine	Main Use or Function of Device
Crowbar	*to put pressure on one end to pry open something*
Clothes line	*to hold and move clothes along a line by a hand pulling*
Wheelbarrow	*to move a load*
Car ramps	*to lift a car up off the ground*
Wood screw	*to fasten or hold materials to wood by sliding or cutting through the surface*
Scissors	*to cut or pry apart materials such as paper or cardboard*

3. Illustrate the three types or classes of levers. Draw each type. Label the diagrams.

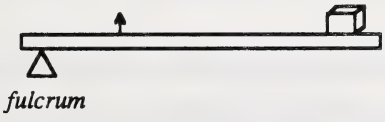
Class I



Class II



Class III



4. If you have two wheels, a big wheel and a little wheel, working together as a wheel and axle, which one of the wheels is the axle?

   The little wheel is considered to be the axle.

Section 1: Activity 3

This activity is designed to provide a hands-on type of experience. It is suggested that students start with a simple, less complex device such as something you would find in the kitchen or office. Suggest that students work on something that is old or worn and that they could label the parts when they take it apart so they know how to put it back together. Students should avoid taking apart any electrical device, and safety should be emphasized. Some devices that could be taken apart are a musical instrument, a curtain rod and pulley, an old toy, a watch, or a bench vise.

For the two simple devices you worked on, tell what simple machines are involved and what function the simple machines have.

There will be a great variation in the answers, but students should show the ability to recognize the role of simple machines in the operation of a device. An analysis of a bench vise follows:

Device	Simple Machines	Functions
Bench vise	*lever*	*The lever serves as a handle to apply the turning force.*
	screw	*The screw forces the jaws together in order to provide clamping.*

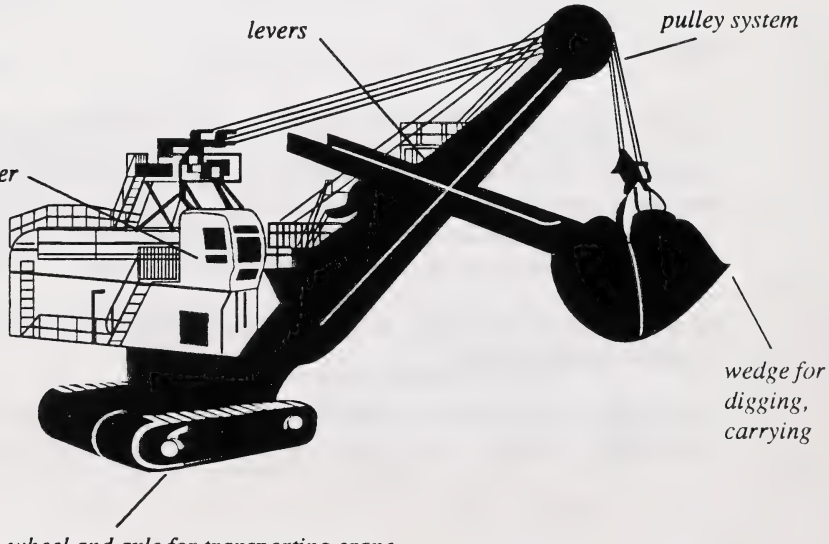
Section 1: Activity 4

For this activity a larger device, such as a model toy, lawn mower, tractor, or appliance is needed for observation.

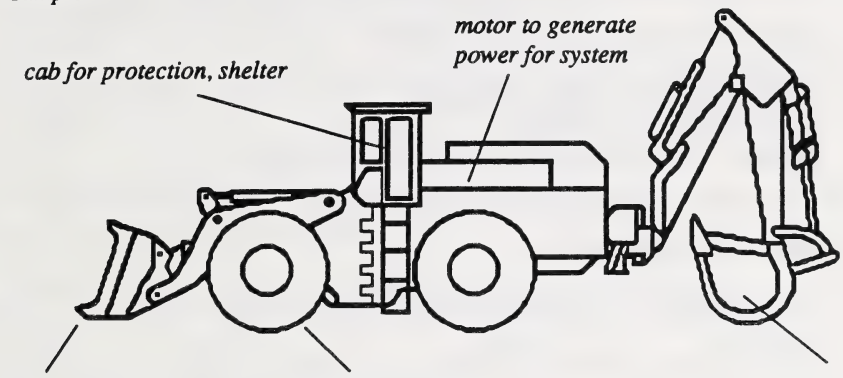
1. In the space provided, draw or trace a picture of a more complex machine. Break the machine into its subsystems, label these systems, and describe the function of each system. (Hint: Remember when you were given a model, a toy, or a doll of some kind, and there was a diagram showing the parts and how to assemble it? Use the same idea.)

   Students should be choosing a more complex machine to observe. The student does not literally have to take the machine apart, but instead sketch the machine and label the parts. Answers will vary but samples have been provided:

   Sample 1:



Sample 2:


motor to generate power for system
cab for protection, shelter
front-end loader for carrying, digging
wheel and axle for transporting machine around
backhoe for grasping, digging, carrying

2. Provide a brief description of each term in the following space. The first one is done for you.

   a. part: a small piece used to make a simple machine

   b. simple machine: *usually made up of one or more parts that provide energy to perform a task or job*

   c. subsystem: *usually made up of one or more simple machines designed to carry out or perform a task*

   d. complex machine: *made up of one or more subsystems designed to carry out many tasks*

Section 1: Follow-up Activities

Extra Help

1. Name three subsystems of a bicycle. Explain what each part does to help the whole bicycle work properly.

   Answers will vary.
   The braking system helps stop the bicycle.
   The wheels, axles, and spokes move the bicycle along.
   The gears and pedals transmit the energy to move the bicycle and rider.

2. List three parts of a bicycle and describe which type of simple machine they represent.

   Answers will vary. A sample answer follows:

   The braking bars are made up of levers.
   Each wheel is a wheel and axle.
   The bolts, used to connect pedals to bicycle, are screws.

3. Make a list of ten machines.

   Answers will vary, but students should provide a wide range of both simple and complex machines.
   Some machines are a stapler, a tractor, a can opener, a rocket, a C-clamp, and a crowbar.

4. What is the difference between a simple machine and a complex machine?

   The difference between a complex machine and a simple machine is that the complex machine is usually made up of one or more subsystems which in turn are made up of one or more simple machines.

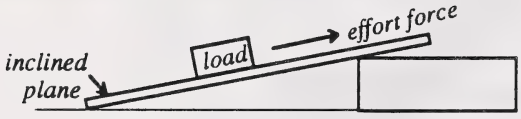
Enrichment

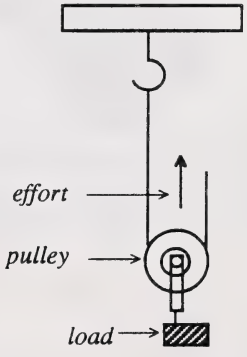
If some lab materials are available to you, you could gather a smooth board, pulley systems, spring balance, and a building or construction kit such as those referred to on page 71 of *Science Directions 8*.

You can use the diagrams in the textbook to help students build several types of levers, pulley systems, or inclined planes.

1. Draw or sketch one pulley or inclined plane system that you built. Label your diagram.

   Answers will vary, but some examples of sketches are provided.





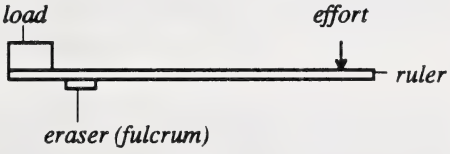
2. Compare the amount of effort you spent lifting the load directly, using your hand and arm, with lifting the same load using the pulley or the inclined plane.

   Answers will vary. Students should discover that it requires less effort with the pulley or inclined plane.

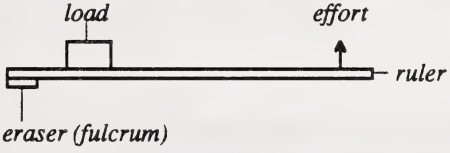
3. Sketch the three classes of levers you built. Label your diagrams. Draw an arrow to indicate in what direction the effort is applied.

   Answers can vary. A sample answer is shown for the use of a ruler and eraser.

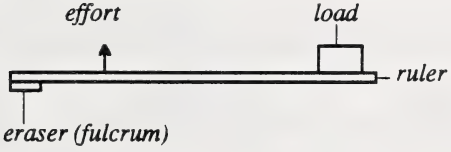
Class I



Class II



Class III



4. Describe what happened to the effort required to lift the load with each type of lever. Did the effort change as you changed the type of lever?

   For Class I levers, the effort is in the opposite direction to the motion of the load. The fact that the effort is down may make the effort easier to apply. If the fulcrum is closer to the load than the effort, then the effort is actually less than the load.

   For Class II levers, the effort is less than the load. The effort is in the same direction as the motion of the load.

   For Class III levers, the effort is more than the load. For Class III levers, the load moves faster than the speed at which the effort is applied. That can be an advantage. The effort is applied in the same direction as the motion of the load.

Section 2: How Are Machines Designed?

Section 2: Activity 1

1. List at least three examples of linking. For each example, give the advantage that the linking provides.

   Answers will vary. Try to encourage students to think of the advantages such as speeding up the work, or adding more force, or transferring of energy.

2. Recall your use of the words *work*, *energy*, and *force* in Section 1. Did any of your examples of linking machines in question 1 result in a change in the amount of work, energy, or force? Using one example that you can think of, or one that you already gave in question 1, describe what changes took place.

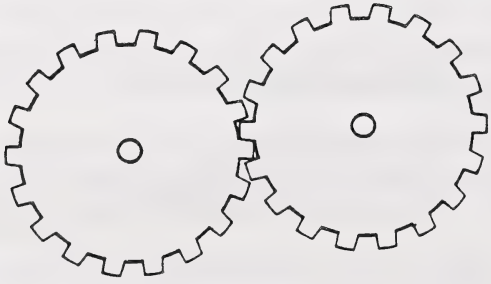
   Answers will vary, but most students will indicate that by joining something together, it will take less effort or force to move or lift the object. (The energy used may be more but each part of the linkage may have to do less work.)

Section 2: Activity 2

You may find it useful to show the video *Science and Technology: Acting in Turn* at this time. This video describes the historic development of the gear and its importance to machines. While viewing this video, students can look for changes in the gear that took place over time.

1. Draw and label a gear train (two gears) in which the driving gear and the driven gear rotate at the same speed.

   The diagram should show two gear wheels having the same number of teeth and being the same size.



2. Explain how multiplying gears and reducing gears work. Give examples of machines that use these types of gears.

   In this answer, examples may vary.

For multiplying gears, the driven gear will be smaller than the driving gear; hence, the driven gear will move faster resulting in a gain in speed and a loss in force. A kitchen hand mixer has multiplying gears.

For reducing gears the driven gear is larger than the driving gear. Therefore, the driven gear will move more slowly resulting in a loss in speed and again in force. A bicycle and a car use reducing gears when in low gear.

3. Make a list of five machines that you know of that use gears or gear systems.

   Answers will vary. The following use gears: car, motorcycle, mixer, bicycle, truck, turbine, drill, and watch.

4. Could a gear system be used to change the direction of force? If the answer is yes, describe a machine that does this. (Hint: You might find one in your kitchen.)

   Yes, gears can be used to change the direction of force. Examples would be a hand-operated drill, an ice cream or potato food scoop, or reverse in a car.

Section 2: Activity 3

1. Calculate the number of gears in bicycles with various numbers of front and rear sprockets.

   Enter your calculations in the chart.

Number of Front Sprockets	Number of Rear Sprockets	Number of Gears
1	5	*5*
2	5	*10*
2	3	*6*
2	6	*12*
3	4	*12*
3	6	*18*
3	5	*15*
4	5	*20*

2. Describe several observations about the gear system on a ten-speed bicycle.

   Students' answers will vary. Look for the following points:

   - *The gears do not mesh, but they use a chain.*
   - *The bike has large and small front sprockets.*
   - *The bike has five different sizes of rear sprockets.*
   - *You can change speed or force by moving the chain from one combination of sprocket to another.*

Section 2: Activity 4

For this activity, it is recommended that students have a ten speed bike to examine. If a bicycle is not available, a bicycle manual or a reference book from the local library may be found helpful.

Students have two pathways to follow depending on whether the student has a bicycle to work with or not. Encourage them to work with a bicycle if at all possible. An attempt was made to keep the investigation at a level simple enough if the student follows the step-by-step directions. Students may express some concern with the understanding of the words diameter and circumference when measuring the rear wheel.

1. What is the circumference of your bike's wheel? Show how you calculated your answer.

   Answers will vary. For a diameter of 65 cm, the circumference is $65\ cm \times 3.14 = 204\ cm$.

2. Complete the chart according to the directions that follow.

   Chart entries will vary, but ratios should decrease as rear sprockets go from A to E. Also the ratios using front Sprocket A, for the most part, will be smaller than those using front Sprocket B. However, there will be some overlap in the ranges. For a sample table, see the chart for the next question.

3. Using the information given about your bicycle and using the directions in Part A as a guide, complete the table.

The answer should be as follows:

Front Sprocket	No. of Teeth	Rear Sprocket	No. of Teeth	No. of Turns of Rear Wheel for One Turn of Pedal	Distance Travelled for One Turn of Pedal
Example	50	Example	30	$\frac{50}{30} = 1.7$	$1.7 \times 220 \text{ cm} = 374 \text{ cm}$
A	*40*	A	*16*	$\frac{40}{16} = 2.5$	$2.5 \times 220 \text{ cm} = 550 \text{ cm}$
A	*40*	B	*18*	$\frac{40}{18} = 2.2$	$2.2 \times 220 \text{ cm} = 484 \text{ cm}$
A	*40*	C	*22*	$\frac{40}{22} = 1.8$	$1.8 \times 220 \text{ cm} = 396 \text{ cm}$
A	*40*	D	*24*	$\frac{40}{24} = 1.7$	$1.7 \times 220 \text{ cm} = 374 \text{ cm}$
A	*40*	E	*28*	$\frac{40}{28} = 1.4$	$1.4 \times 220 \text{ cm} = 308 \text{ cm}$
B	*48*	A	*16*	$\frac{48}{16} = 3.0$	$3.0 \times 220 \text{ cm} = 660 \text{ cm}$
B	*48*	B	*18*	$\frac{48}{18} = 2.7$	$2.7 \times 220 \text{ cm} = 594 \text{ cm}$
B	*48*	C	*22*	$\frac{48}{22} = 2.2$	$2.2 \times 220 \text{ cm} = 484 \text{ cm}$
B	*48*	D	*24*	$\frac{48}{24} = 2.0$	$2.0 \times 220 \text{ cm} = 440 \text{ cm}$
B	*48*	E	*28*	$\frac{48}{28} = 1.7$	$1.7 \times 220 \text{ cm} = 374 \text{ cm}$

4. **Understanding the Problem:** What was the problem you had to solve in Activity 4?

The problem was to find out how far the wheel turns for one complete turn of the pedal in every gear:
1st gear, 2nd gear, . . . etc.

5. **Developing a Plan:** What plan did you use to solve the problem? In your own words describe the method you followed. It will be similar to the directions you were given.

   Students' answers will vary, but their plan will be similar to the directions. Their method would involve marking one tooth on each of the sprockets, then counting the number of teeth on each sprocket. See a typical step-by-step plan as follows:

   - *Turn your bike upside down so that it rests on the handle bars.*
   - *Next measure the circumference of the rear wheel and record it at the top of the chart.*
   - *Count the number of teeth on each sprocket and record the number on the chart. Do this for each of the two front sprockets and the five rear sprockets. Use the correction fluid or other marker to mark one of the teeth and then count around the wheel until you reach the mark.*
   - *Calculate the number of turns of the rear wheel by using the formula:*

     $$Ratio = \frac{teeth\ of\ front\ sprocket}{teeth\ of\ back\ sprocket}$$

   - *Calculate the distance the rear wheel travels by multiplying the circumference of the wheel by the gear ratio.*

6. **Carrying Out the Plan:** What happened? Did you determine how far the wheel turns for one complete turn of the pedal in every gear? How did you use the marker? What happens as you gear up? gear down?

   Student answers will vary, but they should indicate that they were able to find a solution to the problem. They should recognize some patterns. When they gear up from 1st to 2nd to 3rd to 4th to 5th, the number of turns of the rear wheel increases. When they gear down from 5th to 1st, the number of turns decreases. Lower gears require less effort; higher gears require more effort. However, with more effort you gain speed.

7. **Evaluating:** Did your plan, or method, successfully solve the problem? Did you have to alter your method?

   Answers will vary. Encourage students to go back to the original problem: did they solve that problem? How does the student know this? If they followed the specifications, used a marker, and turned the pedal one complete revolution while counting the teeth on the sprocket, they were probably on the right track.

8. If you were riding your bicycle up a steep hill, what combination of front sprocket and back sprocket would you use? Explain why.

   You would use the combination of smaller front sprocket and larger back sprocket. This combination allows for less effort and better mechanical advantage.

9. If you were riding your bicycle on a level, smooth road and you wanted to go fast, what combination of front and back sprocket would you use? Explain why.

   You would use the combination of large front sprocket and smaller back sprocket. This allows for maximum speed, but you need more force or effort to pedal.

10. When touring it is to your advantage to keep a constant rhythm or, in other words, to pedal at the same pace. What factors would require you to gear up or gear down?

    Students should apply what they learned about gearing up or down. Factors such as wind, climbing hills, and ground conditions affect the combination of gears chosen. Another factor may be the physical condition of the rider.

11. If you were travelling against a strong wind, which gear combination would be easier to use? Choose I or II.

    II

Gear Combination	# of Teeth on Front Sprocket	# of Teeth on Back Sprocket
I	48	18
II	48	16

Students should choose II since the number of turns is less, or the speed is slower in II; therefore, the rider has to put less effort into pedalling.

The ratio for I is $\frac{48}{18} = 3.4$, *and for II it is* $\frac{48}{16} = 3.0$.

12. If you were on level ground, there was no wind, and you wanted the gear combination that would give you more speed at the expense of having to push harder on the pedals, which one would you choose? Choose I or II.

    I

Gear Combination	# of Teeth on Front Sprocket	# of Teeth on Back Sprocket
I	48	14
II	40	16

    The ratio for I is $\frac{48}{14} = 3.4$ *and the ratio for II is* $\frac{40}{16} = 2.5$. *Therefore I should be chosen since it provides for greater distance for each turn of the pedals. This allows for greater speed.*

13. Your bicycle is a machine. If you use the bicycle frequently, what kind of maintenance would be necessary to keep the bike running well? (Hint: Think about friction, which occurs when parts rub against each other.)

    This question anticipates the idea of efficiency introduced later. Students should answer that to run well, a bicycle should be lubricated or oiled especially where parts rub against each other (friction). They may also suggest tightening bolts (screws) and replacing parts that they may wear (e.g., brakes).

Section 2: Follow-up Activities

Extra Help

For this Extra Help, it would be helpful to have a small device with gears to look at.

1. Describe the gears. How many gears are linked together? How many teeth are on each one? Is one wheel larger than the other?

    Answers will vary. One answer follows:
    Two gears are linked. The big gear has 48 teeth and the little gear has 12 teeth. The gears turn in opposite directions and the smaller gear turns more quickly.

2. Draw a rough sketch of the gears, and indicate on your diagram (by using arrows) the direction each gear is turning.

    Answers will vary. If there are only two gears, they will move in opposite directions.

3. Give an example of a machine that uses reducing gears. Explain why reduction gears are needed and how they work.

   Answers will vary. Some machines using reducing gears are cars and bicycles in low gear. Also a clock uses reducing gears to move the hands very slowly. In general, the reducing gears are used to reduce the speed of rotation of the driven gear.

Enrichment

1. Write a poem or story about gears. You may want to include the idea of how the gear was first used in early times compared to how gears are used today. Your poem or story might include the words *wheel*, *energy*, *link*, *effort*, *friction*, *teeth*, and *mesh*.

   Due to creativity, the stories and poems will vary greatly. The composition can refer to the change of gears from wood to metal, their use in water wheels and in turbines, and their contribution to changes in the modes of transportation. Rhyme can be used.

2. Sometimes gears break and get worn down because of friction. Suggest ways in which people have attempted to solve this problem.

   People use lubricating materials such as water, oil, and grease to reduce friction and prevent wear.

Section 3: How Can I Build a Machine?

Section 3: Activity 1

1. List several simple functions that you might want your machine to do.

   Answers will vary.
   One function might be to lift a small object 2 m.

2. Pick just one of the ideas you thought of for question 1. List the one task you want your machine to perform. Remember to keep it simple.

   Answers will vary. Accept only tasks for which you feel the student can build a machine. One task that could be chosen is to carry a 50 g object a distance of 2 m.

3. Write your specifications in the space provided. Be brief.

   Answers will vary. Specifications for moving an object might be the following:

   - *It must move the object a distance of 30 cm.*
   - *The materials or machines used will consist of an inclined plane, a pulley, and a lever.*
   - *The machine will be powered by human energy (chemical). e.g., A crank or handle will be turned.*
   - *It must be able to move a 500 g weight.*
   - *It should not take any more than one or two hours to make with all materials present.*

Section 3: Activity 2

For this activity, a construction set is recommended but not required. Other material for construction of a machine may be needed -- especially if there is no construction set, e.g., tape, cardboard, glue, screws, wheels, pins, elastic bands, battery-powered motors, etc.

1. List the materials for your machine.

   Answers will vary depending on the machine being built. Materials could be a construction set, tape, cardboard, toothpicks, nuts and bolts, paper rolls, thread, a motor, and elastics.

2. In the space provided, describe your plan for solving the problem. Indicate in your answer how you are building your machine; use a diagram or a sketch. Have you considered more than one way of building your machine? Did you get your idea entirely on your own or from other sources? What type of power or source of energy will you need?

   Answers will vary, but keep the following in mind:

   - *There is a diagram or sketch of what the machine will look like (label the parts).*
   - *If students are building the machine by themselves, they might not think of alternate methods. They may express an answer after they try to build.*
   - *The student gets help and works with some supervision.*
   - *The plan is simple. Plans may use human power or batteries.*

   Comment: Students may proceed with building their machines only after you have approved the plans for safety. The plans should, besides being safe, also be simple enough to be carried out.

Section 3: Activity 3

1. Describe any difficulties you had when you were building your machine.

   Answers will vary.
   Some students will express difficulty with moving parts – linking them with enough strength or possible friction problems. Others may have chosen a project that is too difficult for their resources to handle. Suggest they redo their plan if the difficulties cannot be overcome.

2. Describe any changes you made in your plan after you started to build.

   Answers will vary. Many students will troubleshoot. Very few students will build something perfectly from start to finish. Changes may be structural – adding a part for more strength or tension or using a different material.

3. At what point did you decide that you had completed the building of your machine? Hint: Think back to the problem you had to solve and the specifications you had to meet.

   Answers will vary. If the students do not complete all of the requirements they originally set out for the machine, they should be encouraged to make changes until it works. At some point, the student has to decide if the majority of the requirements were met and the machine works fully or partially. For some students, the fact that the machine works or runs may be the point at which they were finished or completed.

Section 3: Activity 4

1. Did your machine work? Were you satisfied that it met your specifications? Why or why not?

   Answers will vary. Check to see if the machine that was built met all the specifications. It is possible that one of the requirements was too difficult or maybe physically impossible for the materials used; therefore, think of the machine as a partial success. Note that building a machine is not an easy task, so that partial achievement of the set requirements can be considered a success.

2. Could you identify problems with excessive friction or with the fit of moving or meshed parts? If the answer is *yes*, describe the problems.

   Answers will vary. Students using pulley systems for example, might experience friction if parts are not lined up, or their power source may not provide enough energy.

3. What changes did you make or would you make next time if you could rebuild your machine?

   Answers will vary. Again, changes for strength, ease of operation, and specifications to be met would be possible answers.

4. What form of energy did you use to power your machine?

   Answers will vary.
   Some energy sources are human, electrical, fuel, elastic, solar, and heat.

5. Can you think of **alternatives** or different forms of energy that you could have used to power your machine?

   Answers will vary.
   Some alternatives are batteries, a steam engine, or elastic energy.

6. What safety factors did you have to consider when building your machine?

   Answers will vary, but safety is a necessary and important factor. Students may recognize the need for guards covering belts, chains, gears or pulleys; protection from heat or hot surfaces; and protection from cutting surfaces, etc.

Section 3: Follow-up Activities

Extra Help

For this Extra Help, two devices used in a kitchen, such as a can opener, cutter, nutcracker, nail clipper, or even a jack-knife, are needed.

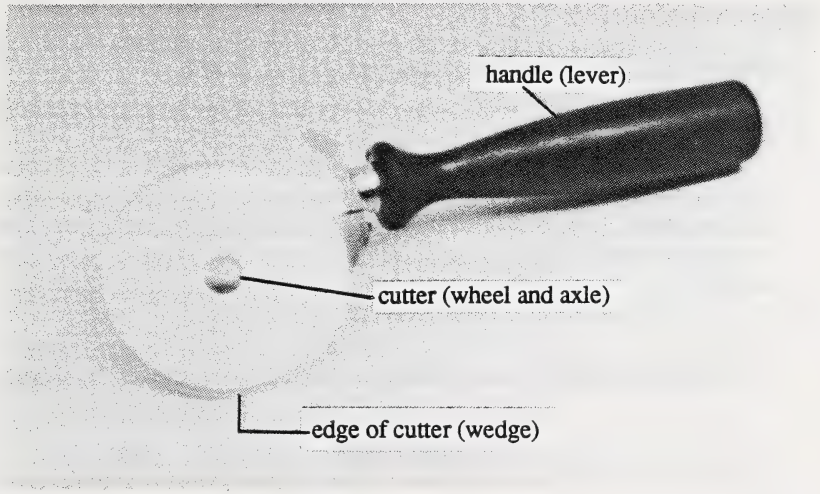
1. List two items used in the kitchen to perform simple tasks.

   Answers will vary.
   An egg beater and a corkscrew are used in the kitchen to perform simple tasks.

2. Using the diagram of the pizza cutter as an example, choose one of the items you listed and make a sketch of it. Label the simple machines involved.

Answers will vary, but labelling should be as shown for the pizza cutter:

Pizza Cutter



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3. Using the machine you picked to answer question 2, think of how you could build the same machine using different materials.

Answers will vary, but look for use of different materials such as metals, plastics, and wood. They should put to use the knowledge gained from the structure and design module in Grade 7.

4. Could you think of ways in which your design was better than the original device? Could you think of ways in which yours is not as good?

Student answers will vary, but look for difference in strength or flexibility of materials. For example, the students might be more efficient and need less effort. It might save more time or use less fuel.

Enrichment

1. What type of machine was invented and who built the machine?

Answers will vary greatly, but students should be able to use their research skills to find stories of inventions in any encyclopedia or library. Recent inventions would be found in newspapers or magazines.

2. Do you think all inventors use basically the same steps you followed when you were making your machine? Would the steps always be in the same order? Explain your answers.

   Yes, in most cases, scientists would follow the technological problem-solving steps although not necessarily in the same order. Sometimes an observation is made that results in troubleshooting or changing the existing machine. As the result of testing the change, a design or plan for a new machine is drawn up.

Section 4: Did Your Machine Stand the Test?

Section 4: Activity 1

You may want to show the video *National Geographic Specials: Man – the Incredible Machine.* This interesting video shows motion of the skeleton and joints by way of X-ray pictures. After viewing the video, students should be able to answer the question: How is the human body like a machine?

1. Look at the following chart. Fill in the left column to answer the questions in the right column.

Human Body	Car	Question
• *The energy comes from the food that is eaten.*	• uses fuels such as gasoline and propane, which are natural non-renewable resources	Where does the energy come from?
• *Muscles use the energy to move, walk, run, and exercise.*	• carries goods, transports passengers, sometimes pulls	What kind of work is done?
• *The digested food is converted into energy through respiration.*	• burns gas to power the motor which uses a transmission (gears) to turn the wheels of the car	How does the machine convert energy?
• produces wastes such as CO_2 and water	• produces waste gases such as carbon monoxide and heat, and it burns oil	What waste products are given off?

Section 4: Activity 2

1. Fill in the blanks. (Use the chart or forms of energy list to help you.)

   a. When skiers stand at the top of the hill, they have *potential* energy.

   b. A radio uses *electrical* energy to produce *sound* energy.

   c. When a skier rushes down the hill, this is an example of *kinetic* energy.

   d. *Magnetism* is a type of energy used to hold items on the side of a refrigerator.

   e. A thunderstorm produces *electrical* energy, *sound* energy, and *light* energy.

   f. A car converts *chemical* energy into *mechanical* energy.

2. For each device listed, describe what form of energy is being used, and what form of energy is being produced.

   a. radio: *A radio converts electrical energy to sound energy.*

   b. stove: *A stove converts electrical or chemical energy to thermal or heat energy.*

   c. bicycle: *A bicycle converts human (chemical) energy to mechanical energy.*

   d. television: *A television converts electrical energy to light and sound energy.*

3. In this section you were asked to think back to the machine you built in Section 3. What was the power source you used?

   Answers will vary, but students likely used chemical or electrical energy.

4. What alternative power sources could you have used? List them.

   Answers will vary depending on the type of machine built and the resources available.

5. In the space given describe changes you would need to make in the design of your machine to accommodate the different power source?

   Answers will vary, but students may indicate that connecting devices such as gears, belts, and pulleys are needed.

6. Refer to page 92, Selecting an Energy Source, in your textbook. Look for the different sources of energy that are used to supply various communities. Make a list of the sources.

   The energy sources used are

   - *coal (to heat water to change to steam to run electrical generators)*
   - *atomic energy*
   - *solar energy*
   - *gravitational potential energy (falling water turns electrical generators)*

7. For the machine you designed in Section 3, list some advantages and disadvantages of the different or alternate energy sources you chose.

   Answers vary. Advantages can be that the source is less expensive, cleaner, more efficient, and easier to obtain and use. Disadvantages can be that the source pollutes, is more expensive, is less efficient, and is harder to obtain and use.

Section 4: Activity 3

Students will need materials to make a self-propelled machine. The materials required will depend on the design of the machine. Materials needed may be paper, wood, tape, paper clips, wheels or margarine dishes, screws, an elastic band, etc.

1. **Understanding the Problem:** What is the problem you are trying to solve? Are there any standards, requirements, or specifications you have to follow?

   Students should indicate clearly the specifications of what the vehicle will be able to perform. For example, the vehicle will transport a hard-boiled egg a distance of 3m, and it is to be powered by a 15 cm elastic band.

2. **Developing a Plan:** What is your plan or design? Draw a sketch of your design.

   Answers will vary. Students should now be familiar with writing a step-by-step plan. If students have no ideas, then suggest they look at examples in a toy store. They should include an indication of materials used, a diagram or sketch, and instructions.

3. **Carrying Out the Plan:** Describe what happened as you carried out your plan.

   Student answers will vary, but look for even partial success. If their device fails to operate, they should describe the changes they had to make.

4. **Evaluation:** Did your vehicle meet all the specifications? How could you change the design to improve the ease of operation? Was your machine self-propelled? How far could it travel? How could you change your design to increase the distance travelled?

   Answers will vary, but check to see if they did meet the original specifications set out for the machine. A statement regarding design change is that the operation could be improved by tightening parts for strength or by lubricating moving parts.

5. What safety factors did you take into consideration when building your vehicle?

   Answers will vary. If they built something with a propeller, then a guard may be appropriate. The elastic band must be secured so that it does not shoot off.

6. Is your vehicle's source of energy (the elastic band) an example of potential energy? kinetic energy? or both?

   The elastic band has potential energy or stored energy. When the vehicle goes into motion, there is kinetic energy. So the answer is both potential and kinetic energy.

7. What other sources of energy could you have used to make your vehicle move if you did not have to use an elastic band?

   Answers will vary. Students could have used chemical energy, in the form of batteries, wind energy, magnetism, and elastic energy from a spring.

Section 4: Activity 4

A pathway in this activity involves a field trip to a local powerplant. You may want to assist in deciding whether to go on a field trip or not.

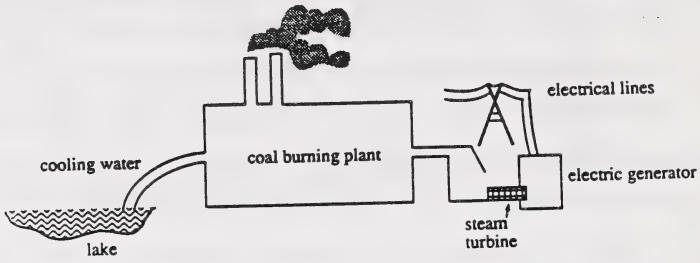
1. How does the power plant for your area generate the electricity produced? Include in your answer all the energy conversions that take place – be specific.

   Most areas in Alberta get the source of energy for light or power from electricity. Homes are usually heated by gas or fuel of some sort.
   Many of the generating stations in Alberta convert energy as follows:

   - *coal burning* ⟶ *thermal (heated water)* ⟶ *steam* ⟶ *steam turbines (mechanical)* ⟶ *electrical*
   - *falling water (gravitational)* ⟶ *turn turbines (mechanical)* ⟶ *electrical*
   - *fuel (chemical energy)* ⟶ *turn motor (mechanical)* ⟶ *generates electricity*

2. Sketch and label a diagram showing how the electricity is produced and how it actually gets to your home. Refer to the diagram on page 92 of your textbook for help.

   Answers will vary, but a typical student diagram might be as follows:



3. Refer back to your answer for question 1. Discuss the advantages or disadvantages of using this method of generating electricity.

   Various answers are possible depending on the method of generating electricity. Some sources are more efficient and cleaner. Others produce more waste heat and contribute to acid rain and other forms of pollution.

4. Usually when one form of energy is converted to another form of energy, heat or thermal energy is given off. Can this be a problem? How?

   Heat is produced and this waste heat is sometimes lost to the atmosphere. This is inefficient. In some cases, the heat goes back into the lake reservoir or river which in turn affects the environment.

5. What special problems are there with the use of fossil fuels?

   The burning of fossil fuels can create pollution in terms of acid rain and the build-up of CO_2 (carbon dioxide) causing the green-house effect.

Section 4: Follow-up Activities

Extra Help

1. Fill in the blanks with the correct word.

   a. Machines require *energy* to run.

   b. *Energy* comes in many different forms.

   c. *Energy* may be converted from one form to another form.

   d. To generate power (electricity) many different sources of *energy* are used.

   e. Some of these sources are renewable but many of them are not renewable. Therefore, the efficient use of *energy* is important to the environment.

2. List two machines that you use at home.

   The water tap, can opener, and egg beater are some machines used in the home.

3. What forms of energy do these two machines use?

   Most of these machines will use either chemical, mechanical, or electrical energy.

4. Can you think of any way that you could use these machines more efficiently so that you do not waste energy?

   Answers will vary. Suggestions might include such things as turning machines off when not in use or needed; maintaining them by lubrication, so there is less friction; and changing the design to reduce power consumption.

Enrichment

1. Discuss the safety factors you would have to consider if you were selling it to children or adults.

   Student answers will vary, but possible answers would be

   - *use of materials that are non-allergenic*
   - *use of a power source that is safe to touch or non-accessible if not safe*
   - *use of non-flammable materials*
   - *use of materials that do not cut or scrape*

2. What changes would you make to your design, either in materials or energy source, so that your machine would be more marketable? In other words, you would sell more of the toys to the public.

   Answers will vary. Changes might involve using materials for the outer shell that are flexible, non-breakable, but safe; or making the gears out of materials that are strong, do not wear easily, and last longer.

3. If you observe and compare many toys, toy cars for example, you will find that they are propelled in many different ways. List several devices that are used to make them move across the floor.

   Answers will vary. Some examples are included here:

   - *spring-driven – press down and release*
   - *coiled spring – wind-up*
   - *wind or sail powered*
   - *gravitational energy or use of ramp*
   - *battery powered (electrical)*

4. What input energy seems to be the most common among the different converters?

   Chemical energy and electrical energy are most common.

5. Which converter is the least efficient?

   The incandescent lamp is least efficient.

6. Indicate how efficiency is measured. Show the formula.

$$efficiency = \frac{output\ energy}{input\ energy} \times 100\%$$

7. Suppose electricity costs 8¢ per kW•h and you are using a fridge having the Energuide label, shown on page 99 of your textbook. Calculate the cost of the electricity needed to operate the fridge for one month.

   $123\ kW \bullet h \times \$0.08 / kW \bullet h = \$9.84$
   The cost of the electricity is $9.84.

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